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ABSTRACT

This paper is a commentary on three other papers presented at the 1983 American Educational Research Association Symposium on "The Trainability of Information Processing and Problem Solving Skills." The papers focus on certain aspects of the training of complex skills, such as reading, that can presumably be broken down into a variety of skills. In "Teaching Vocabulary-Building Skills: A Contextual Approach," R. J. Sternberg makes the case well for the importance of knowing how to use context effectively to infer the meanings of unfamiliar words and provides a systematic approach that is certainly worthy of experimental study. "Developing Skills by Training to Develop New Automatic Components," by W. Schneider, identifies a number of issues relating to the training of complex skills and challenges what the author views as some prevailing false assumptions regarding these issues. "A Componential Approach to Training Reading Skills," by J. R. Frederiksen et. al, states that learning some of the skills that are essential to reading (via computer-based games) can be made fun, and provides compelling evidence for his claim. All three papers have useful and provocative things to say about the trainability of information-processing and problem-solving skills and, in particular, the complex skill of reading. (Author/PN)

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METHODS, FALLACIES AND GAMES: COMMENTS ON SOME APPROACHES TO TRAINING INFORMATION PROCESSING AND PROBLEM SOLVING SKILLS

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Abstract

This paper is a commentary on three other papers presented at the 1983 American Educational Research Association Symposium on "The Trainability of Information Processing and Problem Solving Skills," Montreal, Canada. The papers focused on certain aspects of the training of complex skills, such as reading, that can presumably be broken down into a variety of component skills. The commentary deals primarily with aspects of the papers that appear to the writer to be subject to debate.

1. OVERVIEW

The topic of the symposium is the trainability of information processing and problem solving skills. It would be appropriate, therefore, to begin by considering what might be meant by information processing and problem solving skills. In fact, however, a more-than-superficial consideration of that question could take up all our available time, so perhaps it will suffice to note that an example of such a skill, and the one that this symposium has focused on, is reading. Although reading may, perhaps, be viewed more easily as involving information processing skills than problem solving skills, the reader's problem can be described as that of "figuring out" from the multiple cues on the printed page, and other information that he brings to the task, what it is that the writer intended to convey. From this perspective it seems not unreasonable to consider reading a problem-solving, as well as an information-processing, task. Other examples of tasks of interest that are mentioned in one or more of the papers are typing, playing a musical instrument, and controlling air traffic.

Now it is clear that the purpose of the symposium is not to address the question of whether such skills are trainable. They manifestly are. People are not born with the ability to read, or type, or play a musical instrument, or control air traffic, as ducks are born with the ability to swim. If people are to do

such things, they must be taught to do them; and the world is filled with existence proofs of the fact that one can be taught to do them, and to do them very well. The general question of interest, therefore, is not "whether" but "how": how to go about teaching high level skills such as these. Each of the three speakers addresses this question in one way or another, at least as it applies to the specific skill of reading.

Sternberg (1983) focuses on the problem of vocabulary building, and proposes a method to facilitate this process. I assume that the importance of an adequate vocabulary, not only for reading but for effective language usage more generally, would not be questioned. However, inasmuch as people obviously do increase their vocabularies in the normal course of language usage without making conscious efforts to do so, one might ask why deliberate attempts to build vocabulary are needed. One answer is because the vocabularies that people acquire spontaneously vary greatly in extensiveness, and the vocabularies of many adults must be considered impoverished. Moreover, people probably differ not only with respect to their vocabularies but with respect to their vocabulary-building skills. That is to say, not only is it the case that some people have more extensive vocabularies than others, but some people are more skillful than others at enlarging whatever vocabulary they already have. This is an important distinction and is fundamental to Sternberg's

paper. His interest is in the teaching of vocabulary-building skills, the purpose of which is to enhance the individual's ability to acquire new words when they are encountered in everyday situations. He describes three approaches to the teaching of vocabulary-building skills and then argues in favor of one of these approaches, although not necessarily to the exclusion of the other two. The approaches he considers are:

- The rote-learning method
- The keyword method
- The method of learning from context

The one he recommends is the third.

Schneider (1983) discusses what he views as four commonly held fallacies regarding the training of high-level skills. Those four fallacies are:

- Practice makes perfect.
- A skill should be trained in a form similar to the ultimate target skill.
- The primary goal of training should be accurate performance.
- The learning of skills is intrinsically enjoyable, so extrinsic motivators are unnecessary.

In challenging these ideas, Schneider makes use of a number of concepts and distinctions that serve to turn the general question of how to teach high-level skills into several more specific questions regarding the conditions under which practice improves

performance, the merits of training skill components as opposed to "total" skills, and so on.

Frederiksen describes an attempt to train, by means of several computer-based games, some of the component skills that are hypothesized to be essential to reading. (The report from which these notes were prepared was Frederiksen, Weaver, Warren, Gillotte, Rosebery, Freeman, & Goodman, 1983.) Three games are described, which are intended to teach three different skills that previous work had identified as componential reading skills. These componential skills involve:

- Perceptual detection of common letter clusters
- Decoding and pronunciation of words
- The use of semantic context to facilitate word recognition.

Experimental data are presented on the performance of subjects both on the training games and on criterion tasks selected to assess the degree to which the effects of training would transfer to tasks other than those used in training and somewhat more representative of actual reading tasks.

In what follows, I will make a few points about each of the papers in turn. I will make no effort to evaluate the papers or to effect any sort of integration, but rather will focus selectively on aspects that strike me as particularly interesting. On the assumption that it is expected of

discussants that they be contentious, I will tend to focus on points that I think are worthy of debate and on assertions or conclusions that seem to me to be questionable. This is not to suggest that reading the papers left me in a particularly contentious frame of mind. On the contrary, I found each of them to be most stimulating and full of good ideas; but they speak for themselves in this regard.

2. STERNBERG'S METHODS

Sternberg describes three methods for building vocabulary: (1) the rote-learning method, (2) the keyword method, and (3) the method of learning from context. He compares these three methods with respect to three "armchair criteria": (1) Internal connectedness (the richness of the individual's cognitive representation of the meaning of the word); (2) external connectedness (the degree to which the cognitive representation of the new word is connected with or related to other cognitive structures); and (3) practical ease of use (ease of applicability of the method to new words encountered in everyday experience). These three criteria were chosen on the assumption that durability and generalizability of learning will be functions of them. Presumably the greater the internal and external connectedness of the representations produced, the more durable they will be, and the easier a method is to use in everyday life, the more general its effects will be. In addition to comparing the methods with respect to these armchair criteria, Sternberg cites some empirical studies of their relative effectiveness. Table 1 summarizes briefly, and perhaps in an oversimplified way, the methods and Sternberg's assessments of them.

With respect to the armchair criteria, Sternberg concludes that both the keyword method and the learning-from-context method

fare reasonably well, and in particular they both do better than the rote-learning method. An important advantage that the method of learning from context has over both the other methods is the fact that it can always be used. For both the rote learning and keyword methods, one must first get the word's definition; indeed each of these methods is really intended to ensure retention of a word and its meaning and not to help find the meaning in the first place. And one does not always have a dictionary at arm's reach when one encounters unfamiliar words in everyday situations.

Sternberg is careful to point out that he is not arguing for the adoption of any single method to the exclusion of other methods, but only making a case for inclusion of the learning-from-context method in any vocabulary-training program. One of the burdens of the paper is to make the point that if the method is to be maximally effective, one must have some instruction in its use. A specific training program is described, that is based on a theoretical analysis of the types of external and internal cues that are likely to be useful (external cues are cues found in the context surrounding the word, and internal cues are provided by the morphemes of the word itself), and some ideas about how various aspects of the context in which a new word occurs affect the usefulness of these cues in specific situations.

Sternberg refers to the specification of types of external and internal cues from which meanings of words can be inferred as a competence model. The specification of non-cue variables that determine how well cues can be used in specific situations he refers to as a performance model. In combination, the competence and performance models provide the theoretical basis for the proposed learning-from-context approach.

Training in this method involves first teaching students the various specific external and internal context cues that Sternberg has identified and providing some practice in their use, and then giving training in a seven-step "strategy" for applying the cues. The seven (unelaborated) steps are as follows:

1. Attempt to infer the meaning of the unknown word from the general context preceding the word.
2. Read on. Attempt to infer the meaning of the unfamiliar word from the general context that follows the word.
3. Attempt to infer the meaning of the unknown word by looking at the word parts.
4. Judge whether or not it is necessary to understand the word's meaning in order to understand the passage or the sentence in which it is used. If it is necessary, estimate how definite a definition is required; if it is not necessary, further attempts to define the word are optional.
5. Attempt to infer the meaning of the unknown word by looking for specific cues in the surrounding context.
6. Attempt to construct a coherent definition, using

internal and external cues, as well as the general ideas expressed by the passage and general world knowledge.

7. Check definition to see if meaning is appropriate for each appearance of the word in the context, and with general knowledge concerning the passage.

A distinction that is implicit in Sternberg's discussion of the various methods he describes is the distinction between looking up and figuring out. This is, I think, a rather fundamental distinction, the applicability of which extends far beyond the problem of vocabulary building. Looking up and figuring out are two ways of getting answers to questions. In the context of vocabulary learning, the question is "what is the meaning of this word?" and the two methods of answering it are to look it up in a dictionary and to figure it out from context. The distinction applies, however, to information-seeking problems in general. One often has the option, though not always, of looking up the answer to a question or figuring it out in some less direct way.

In the context of vocabulary learning, each method has something to recommend it and some limitations. Looking up a definition may be easy provided a dictionary is at hand. Furthermore, the answer one gets in this case is certain to be correct in some sense. On the other hand, the method is not always an option because a dictionary is not always available. Moreover, just because looking up a definition is so easy, the

definition that is found may not be retained as well or as long as one that one infers with some effort. Finally, many of the subtleties of word meanings and word usage probably are not represented in dictionary definitions. The same verb in different contexts can connote quite different actions, for example, even though the same dictionary definition is appropriate in each case. And unless the reader appreciates the difference, it is not clear in what sense he understands the meaning(s) of the word in those contexts.

Figuring out word meanings has the advantage that it does not require the use of a dictionary. The meaning that one figures out may be remembered better because of the effort that one has put into deriving it and the coupling of this word with others in one's vocabulary that may have occurred as a consequence of the figuring-out process. On the other hand, efforts to figure out meanings sometimes fail, or worse yet they may produce incorrect results that can go undetected for some time. Most of us have probably had the experience of discovering, upon looking up the definition(s) of a word that we thought we understood, that it meant something rather different than we had thought. Or if we find it difficult to admit to that, surely most of us have been aware, from time to time, of someone else using a specific word in an inappropriate way.

Thus, one of the risks associated with the method of

learning from context is the risk that some of the meanings that one derives in this fashion may not be correct. It is difficult to assess the seriousness of this risk, but I believe a case could easily be made for the assumption that communication between people is not nearly as effective as it might be simply because the same words often mean different things to different people. Clearly it is not essential to know a word's dictionary definition to be able to use the word; all of us use words that we would have difficulty defining very adequately. Moreover, as Sternberg points out, typically we do not learn new words by explicitly learning their definitions. One wonders, however, if language usage might not be greatly enhanced and communication improved if all of us took the trouble to consult the dictionary more frequently, for the very good reason of trying to maximize the probability that when we use the same words we will be using them to mean roughly the same things.

I do not believe that looking up and figuring out should be viewed as competing strategies. Both are important and useful. It is important to know how to do both (e.g., how to use effectively not only dictionaries but other sources of factual information, and how to make valid inferences and plausible conjectures from information in hand). It is also important perhaps to recognize when to use the one approach and when to use the other. It seems a bit silly, for example, to try to figure

out the answer to a statement of fact, especially if it is the subject of a controversy or debate, when one might settle the issue easily by consulting an appropriate reference.

* * *

Conjecture: The method of learning from context works best for people who already have a good vocabulary and a reasonable knowledge of the language. To use internal contextual cues effectively one must be able to decompose words into stems and affixes and to recognize meanings of the components. To use external cues to advantage, one must recognize the meanings of words that make up the external context of the word whose meaning must be derived. It seems likely that how successfully the method may be applied will vary with the degree of linguistic sophistication of the user. If that is the case, then the method should work better with students who already have good language skills and conceivably might increase the difference between the performance of such students and that of who lack such skills.

Indeed, Frederiksen, whose paper we will consider shortly, makes the point that "the skilled reader has a sizeable vocabulary of sight words as well as effective and automatic procedures for decoding unfamiliar words" (p. 10). Although he does not say it explicitly, what seems to be implicit here is the idea that the unskilled reader lacks effective procedures for decoding unfamiliar words. Frederiksen and his colleagues have

also obtained results in several experiments that suggest that highly skilled readers are more sensitive to the constraining effects of context on word recognition than are less skilled readers (Frederiksen, 1981; Frederiksen, Warren, & Weaver, 1983). These observations seem to support the idea that the learning-from-context method of enlarging one's vocabulary may be more effective with skilled readers than with unskilled readers.

* * *

Conjecture: In trying to enlarge one's vocabulary in a foreign language, a combination of techniques which includes reading, listening, and drill and practice will probably produce better results than any one technique by itself. Any single method has limitations. If one does nothing but study vocabulary in a drill-and-practice fashion, one will (I believe) have difficulty remembering the words for very long and one will not acquire the ability to recognize them auditorally in context. If one relies solely on reading or listening, and especially the latter, one is likely not to acquire as extensive a vocabulary as one will if one has a systematic method for adding words to it regularly. The fact that daily usage of a language is not sufficient to produce a large vocabulary is apparent from the fact that there are many people who use a given language daily whose vocabulary in that language is very limited.

* * *

Methodological point. How is one to evaluate the relative effectiveness of different methods? The fact that people are able to recall more words immediately after a few minutes of study with method A than after the same amount of study with method B is not compelling evidence that A produces the more lasting effects on vocabulary.

* * *

We should distinguish between two questions:

- What skills should one be taught if the objective is to improve one's ability to enlarge one's vocabulary, and
- Assuming that the skillful use of context to figure out the meaning of unfamiliar words is one effective way to increase one's vocabulary, how can one's ability to use context effectively be improved?

Sternberg's hypothesized answer to the second question is by learning a seven-step procedure that was described above. It is not clear that he proposes an answer to the first question except to say that whatever the approach one takes to vocabulary building, it should include training in the use of context.

Independently of which of the methods described by Sternberg is best for vocabulary learning, it seems safe to say that:

- It is good to know how to use a dictionary effectively; and
- it is good to know how to use context effectively.

A dictionary holds a wealth of invaluable information about one's language. There are few books more essential to any individual

who would be an effective language user than this one. But it is certainly true that a dictionary is not always available, and information about the meanings of words can indeed be derived from the context in which those words occur. The ability to make use of that contextual information is also essential to anyone who aspires to be an effective language user.

* * *

One of the things that all the techniques that are described by Sternberg omit is acknowledgement of the importance of using the words whose meanings have recently been learned. If one wants the meanings really to stick and the words to become incorporated into one's more or less permanent vocabulary, this is probably crucial. Repeated exposure to the words when listening to speech or reading would also probably suffice to stamp them in, but one has less control over the words that one happens to encounter when listening or reading than one does over the words that one produces oneself.

3. SCHNEIDER'S FALLACIES

Schneider claims that there are four "commonly held fallacies about skill training" and that "these fallacies are generally implicitly assumed in most training programs." The word "fallacy" is used in various ways, but one of the meanings it can have, and the one that I believe Schneider intends is that of an untrue belief.

Undoubtedly all of us hold some beliefs that are untrue. In some cases the untrue beliefs that we hold may be harmless or perhaps even beneficial. In other cases, they may be hurtful because they cause us to do things that are silly, inappropriate or antithetical to our goals, socially unacceptable, or harmful to other people. When untrue beliefs have the latter types of consequences, it seems appropriate that they be viewed as problems that should, if possible, be fixed.

Applying Sternberg's proposed strategy for inferring meaning from context, I conclude that when Schneider uses the word "fallacies" in his paper he means to convey the idea of untrue beliefs that have undesirable consequences of some significance. And his assertion that the fallacies he describes are implicitly assumed in most training programs suggests that he believes (1) that the majority of people who are designing training programs are operating on false assumptions and (2) that most training

programs are less effective than they would be if it were not for this fact. I shall comment briefly on each of the fallacies that Schneider describes and on his suggestions regarding what would constitute less fallacious views of how training should be done.

Fallacy No. 1: Practice Makes Perfect.

I agree that practice does not (at least does not often) make perfect. I doubt that very many people really believe that it does. More generally, I suspect that perfection is a state that most of us would be willing to assume is seldom attained. But Schneider is not suggesting that belief in the literalness of the maxim is what is fallacious; he recognizes the maxim as a short-hand way of saying that conscientious consistent practice of a task will bring one's performance of that task continually closer to perfection, and it is this belief that he views as fallacious. Practice, he says, will improve performance on certain types of tasks but not, or at least not much, on others. In particular, consistent-component tasks will benefit from practice, he argues, but varied-component tasks will not. To illustrate these two types of tasks he gives the repeated dialing of the same phone number as an example of the former and the dialing of random phone numbers as an example of the latter.

I find it easy to agree with Schneider's observation that while practice sometimes improves performance, it also sometimes

does not improve it and may even have detrimental effects. Given this view, it makes sense to try to distinguish between the conditions under which practice will improve performance and those under which it will not. But I have several difficulties with Schneider's generalization regarding consistent- and varied-component tasks in this regard, at least if one defines these terms as Schneider's choice of examples suggests.

First, I find the phone dialing example surprising. I would expect considerable improvement in dialing random numbers (especially with push buttons phones). Consider the operation of a cash register by a checkout clerk, the operation of a desk calculator by an accountant, or the operation of a typewriter by a skilled typist. Presumably these are varied-component tasks. If practice has little effect on varied component tasks, how does one learn how to do these things?

Second, supposing that one were to accept the assertion that practice improves performance on consistent-component tasks but not on varied-component tasks, it is not clear to me from Schneider's examples how to distinguish consistent- from varied-component tasks. Consider the tasks Schneider uses to illustrate this difference. We have already noted the telephone dialing example. A second example involved a perceptual training experiment. In this case, the consistent-component (or consistently-mapped) task was one in which the subject always

pushed a button when a given letter appeared on a display, whereas in the varied-component (or variably-mapped) task, the subject sometimes pushed the button when that letter appeared and sometimes he did not. This suggests that the defining characteristic of a consistent-component, or a consistently-mapped, task is one in which a given stimulus always signals the same response. But by this definition should not the dialing of random phone numbers be considered such a task, inasmuch as a given digit always signals the pressing of the same button on the phone dial? (One can imagine ways in which to make this a varied component task in a more fundamental sense: e.g., rearrange the numbers on the phone dial between each trial.)

In distinguishing between consistent- and variable-component phone-dialing tasks, Schneider seems to focus on a higher level of organization than he does when considering the perceptual-learning task. In the phone-dialing case, the consistent-component task is one in which a complex stimulus (a string of digits) and a sequence of movements are repeated over and over; whereas the variable-component task is one in which the complex stimulus and the sequence of movements vary from trial to trial, but the mapping of the components of the stimulus (the individual digits) onto the individual button pushes remains invariant. In short, what one considers a consistent-component task may depend on the level of detail at which one views the task.

Incidentally, what Schneider refers to as the consistent-component phone-dialing task differs from the variable-component phone-dialing task in a way that complicates the interpretation of any differences in performance changes over time. In what I will refer to as the constant-dialing task, the need to encode the phone number and retain it in short-term memory probably quickly disappears: inasmuch as the same number is being dialed repeatedly, the subject has no need to read the number on each trial. This perceptual requirement of the task goes away. This is not true of the random dialing task. In this case the perceptual encoding and short-term memory requirements do not diminish over time. (They might even increase somewhat.)

A third difficulty I have with Schneider's generalization regarding consistent- and varied-component tasks relates to the question of what is being learned. In assessing the relative merits of consistent-component and variable-component training, it is probably important to do so in light of the ultimate training objectives. What kind of ability is the training intended to produce? And in particular is it intended to produce skill at performing consistent-component tasks or variable-component tasks? Consider again the phone-dialing example. The individual who dials the same number repeatedly presumably gets better at dialing a particular number. Of what value is that if the ultimate objective is to become a more efficient telephone

dialer? Might it not be the case that becoming super efficient at dialing a given number would hinder the development of the more general capability? Consider the following experiment. Let one group of subjects practice the random-dialing task while another practices the constant-dialing task. After extensive practice, test both groups on the random-dialing task. I would guess that the subjects who got the constant-dialing practice might do quite well when the test happened to require that they dial that particular number, but less well than the other subjects otherwise.

Perhaps I am pushing the phone-dialing example too hard. But presumably many of the tasks that we perform in our daily lives and that we get skilled at are variable-component tasks. If that is true, a question that arises is: When skilled performance of a variable component task is a training objective, how should the training be done?

Fallacy No. 2: That it is best to train a skill in the form similar to the final execution of the skill.

Here I have difficulty figuring out exactly what it is that Schneider claims the fallacy to be. One problem is a confusion between issue of whole- versus part-task training and the question of whether people learning a new skill (or component of a complex skill) should be taught to do it correctly from the beginning (e.g., fingering on piano, grasp of golf club).

I would be surprised if there were many people who did not recognize the necessity of teaching components of complex skills. When one aspires to produce a concert pianist one does not start by sitting a child down at a Steinway on a concert stage with an orchestra in attendance and ask him to try a Liszt concerto to give him a feel for the total task in the real situation. It is not a case of either (whole task) or (part task), but a matter of degree. The question is not which is right, this or that, but what is the best route to take from here (where I am) to there (where I want to be). At any given point in my training program, what is the most useful thing to do (practice, learn) next, given my ultimate objective?

One may believe that "training in the real situation is often very inefficient" (p. 3, paragraph 3) without believing that it always is. And indeed Schneider believes that at some time in the training process it is helpful to practice the whole task (see page 5, paragraph 2). Most of us would probably think twice before trusting our lives to an airplane pilot, taxi driver, a surgeon ... who had had no practice on the whole task he was about to perform.

As one argument against training in the "real situation," Schneider points out that the real situation may not sequence events optimally (page 3, paragraph 3). However, it may sequence them the way one is likely to encounter them in real life. If in

one's training one only encounters optimally sequenced events, will the results of that training transfer adequately to the real world situation? (Ditto regarding other points abut real situation.)

* * *

It is worth noting, perhaps, that a preference for training in the real situation does not preclude focusing on specific aspects or components of the performance being trained: One can focus on one's backhand in the context of a game of tennis as well as in a separate backhand practice session, etc.

* * *

If one is going to take a part-task approach to training, the first problem that must be faced is that of identifying the skill components that should be taught. And some components of skilled performance are more easily isolated than others. Shooting free throws is an easily isolated component skill in basketball. (Which is not to suggest that this could not be decomposed into subskills.) The ability to pass to the right teammate at precisely the right instant in a fast moving offensive play is less easy to practice in isolation.

* * *

Many good arguments can be made for component training. E.g., the possibility of compressing training, providing

immediate feedback, etc. (Page 5). But these are not necessarily arguments for doing component training exclusively. How about a mixed strategy in which one alternates between practicing the whole task and focusing intently on specific aspects of it. Is this not what many expert performers (athletes, musicians) in fact do?

An approach to skill-learning that I believe many people take quite naturally and perhaps without being especially conscious of it is that of practicing a component, (chunk, segment, aspect) of the target skill that seems to provide the right amount of challenge given one's current level of ability. That is to say, one tends to zero in on those aspects of the target skill that represent the most serious limits to one's overall performance and to focus at a level of detail that constitutes a manageable challenge.

Fallacy No. 3: Train for accurate performance.

Schneider's third fallacy is "that the primary goal of training is to obtain accurate performance." Seeking maximum accuracy is, he claims, often counterproductive; the goal should be to obtain performance of acceptable accuracy, leaving some attention to be allocated to other task components.

Again, it is difficult to decide whether to agree (1) that the idea is a fallacy, and (2) that it is a common fallacy,

without knowing how literally Schneider means for us to interpret his words. I am not convinced that the seeking of maximum accuracy is a very common goal of training, especially during the beginning stages of learning a new skill. I suspect that the more typical goal is to attain some acceptable level of accuracy, much in keeping with Schneider's recommendation. What is considered acceptable may increase as one gets better at the task. I believe Schneider's point is that it is possible to put too much emphasis on the accuracy with which some aspects of a task are performed to the neglect of other aspects of the task, and with that idea it would be difficult to disagree. Whether this is a common problem in training programs is another matter, and one on which I have no basis for an opinion, one way or the other.

Granted that it is possible to put too much emphasis on the accuracy with which a skill-in-learning is performed, the question arises: How much emphasis on accuracy is too much? Here is a question for which it is probably not possible to look up the answer. Unfortunately, it it is not clear either that just by trying hard we can figure it out. For present purposes, it must suffice to recognize that the question is an important one and points up an aspect of training methodology that needs to be better understood.

Perhaps it is worth noting that many skills have an accuracy

threshold that is critical. It is very important to get above this threshold, but how far above may be of lesser consequence. For example, in basketball one only has to be accurate enough to get the ball in the basket. Similarly for many other sports. In driving a car, one must be able to stay in one's lane, to get in and out of parking spaces, etc. But no one expects a learning driver to be able to, say, keep his left wheels on a divider line.

In playing the piano, when the score calls for C, striking B or C sharp will not do. Striking the key dead center may not be important, but striking the right key is. (As a parent who survived the early stages of a child's learning to play a violin, I can attest to the fact that the problem of accuracy is somewhat less dichotomous in this case.)

Fallacy No. 4: Skill learning is intrinsically enjoyable, so extrinsic motivation is inappropriate.

Again, if Schneider means that the belief that all skill learning is intrinsically enjoyable, and that extrinsic motivation is never appropriate is fallacious, I would find myself in agreement, and I suspect enough other people would also that we should question the commonness of the fallacy. On the other hand, if he means to suggest that skill learning never is enjoyable, I would want to disagree. I assert from experience

that skill learning sometimes is enjoyable: I am quite certain I enjoyed immensely learning how to shoot baskets with a basketball, how to do a few tricks on a trampoline, how to drive a car, how to read a little French, and how to play the piano well enough to amuse myself when no one else is around.

It should not be surprising that one may find it unenjoyable when one is forced to learn a skill that one has no interest in acquiring. And undoubtedly children may need extrinsic motivation to keep them at learning tasks the long-term value of which they may not understand. (One of my keener memories of my grammar school days is of the extrinsic motivator that the principal kept in her desk drawer. Sometimes she used it to draw straight lines on the blackboard and sometimes to put a pattern of no particular regularity on someone's buttocks. But, of course, the rights of children were less well recognized in those days and parents were less litigious.) The problem with the use of extrinsic motivators is that of finding effective ones that really facilitate the desired learning without having undesirable secondary effects.

It has always seemed to me that the use of grades as motivators by most school systems has been a mixed blessing. It does work, in a sense; that is to say, students typically work harder (I believe) in a graded course than in an ungraded one. The risk is that grades become ends in themselves and acquire so

much importance that students often see it as no tragedy if they carry nothing permanent away from a course just so long as they received the desired grade.

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The problem of maintaining a learner's motivation at an appropriately high level is perhaps as serious as that of providing the motivation to start. It may be much less difficult to get an individual motivated to start with than to maintain the motivation when the person discovers that progress comes hard and slowly.

* * *

Question: How to make learning fun. (Note. This is different from asking how to add frills to the learning situation so as to make the situation fun. At least I think it is.)

* * *

Summary regarding Schneider's four fallacies: Am I saying that Schneider is attacking strawmen, and that there really are no controversies? That we are all in violent agreement? Not quite. I believe he addresses some bona fide issues on which there are real differences of opinion, but his characterization of certain extreme positions as common fallacies seems to me to overstate the degree to which these positions are widely held among designers of training programs and to oversimplify the

issues involved. I suspect the overstatement was intentional, and in the spirit of bending over backwards to get the rest of us to stand up a little straighter.

4. FREDERIKSEN'S GAMES

Frederiksen describes three microcomputer-based training systems for improving reading skills of poor readers. The approach is based on a view of reading in which reading depends on a number of component processes. It is assumed that a skilled reader executes these processes automatically without attending to them consciously, whereas an unskilled reader has an inadequate set of such automatic processes to support skilled reading. Critical to this view is the assumption that not all people who lack general reading ability do so because of precisely the same underlying problems. Reasons for lack of general reading ability may differ from person to person, which is to say that different people may have trouble reading because of inadequacies with respect to different underlying component skills.

Also critical to Frederiksen's approach to the training of component reading skills via the games he describes is the assumption that the skills on which the games are targeted are indeed component reading skills. This raises the question of how such skills are identified. Clearly, determining that good and poor readers differ with respect to their ability to perform some specific task is not, in itself, good evidence that the task with respect to which they differ represents a skill underlying reading competency. This is the familiar problem of confusing

correlation with causation. I am not suggesting that Frederiksen has done this, but only pointing out that in order to identify a skill as one that is essential to reading ability, one must do more than demonstrate that poor readers are more likely than are good readers to lack this skill.

The three skills that Frederiksen has identified as important to reading ability and appropriate objectives for training are:

- Perception of multi-letter units appearing within words.
- Efficient decoding of orthographic information within words.
- The use of context to facilitate word recognition.

Three microcomputer-based games were developed for the purpose of training each of these three types of skills. I shall not describe the games here beyond noting that they are games in the sense that they each give the player a presumably intrinsically motivating task, and performance is objectively scored thus permitting competition (against a target score, one's previous score, or an opponent's score). Each game also has the feature that that difficulty of the demands of the game is automatically adjusted to match the skill of the player. So, the player typically should be working at the edge of his ability. Complete descriptions of the games are given in Frederiksen, Weaver, Warren, Gillotte, Rosebery, Freeman, & Goodman (1983).

* * *

As an aside, selection of the parameters of the games of the types that Frederiksen has developed appears to be very much a trial and error process. One selects a timing parameter, for example, tries it to see how it works, and then modifies it if it seems not to work satisfactorily. The rules governing the selection and modification of parameter values are not made explicit, and one is left with the impression that it is primarily a matter of evolving a game situation that has the right "feel," a certain fluency of rhythm, and a pace that maintains the player's attention. There are also the problems of difficulty adjustment and scoring: how to do these things in such a way that the player is always being challenged at the appropriate level (the task is sufficiently difficult as not to be boring but not so difficult as to be impossible.). I assume that all this is more art than science at this point.

* * *

Frederiksen and his colleagues have shown quite clearly that practice with their games results in greatly improved performance on the tasks embedded in those games. With the unit-detection-task example, they showed that a few hours of training enabled their subjects to improve to the extent that their performance was better than that of an untrained reference group of very high-level readers. Frederiksen et al. conclude

from this finding "that training of low-ability readers on the perceptual component skill can produce gains in performance that surpass the difference in skill between the highest and lowest reading ability groups tested" (p. 94). (The level of performance of untrained subjects in this task varied inversely with their level of reading skill as indicated by Nelson-Denny scores.) Assuming that the skill that is being trained in this task is in fact the skill that is used in reading, the question of interest is the following: Has the training only produced an improvement in the skill when it is exercised in isolation, or has it also improved the reading process?

Unfortunately, this question is not answered by Frederiksen's work. He did test for, and obtain evidence of, transfer, but the transfer tasks were not reading tasks per se. What the results show is that improvements in performance of a component skill that resulted from practicing that skill in one context carry over to its performance in another context. What one really wants to know, however, is whether what is learned when the skill is practiced in isolation carries over in a beneficial way to the reading task.

The closest Frederiksen came to assessing the effects of training with his games on reading rate, or reading comprehension, in situations in which one is reading for the purpose of acquiring information, was to measure performance on

an "inference task" in which the subject is shown several passages composed of three sentences each. The sentences of a given passage are shown one at a time. The third sentence begins with a blank space, which the subject must fill by choosing the correct conjunctive phrase from two alternatives. Only one of the alternatives is appropriate, given an understanding of the first two sentences. Following selection of a phrase, the subject is asked a multiple-choice question about the content of the sentences. As indicated by performance on this task, subjects who completed training on all three games nearly doubled their reading rate (from 108 to 199 words per minute) without any decrease in comprehension. Frederiksen et al. see in this result the suggestion "that improvements at the level of automaticity of multiple skill components can reduce the effort required in reading text for comprehension" (p. 159). One would like more direct evidence, however, that reading rate and/or comprehension has been improved in situations in which one is reading more extensively from typically formatted prose for the purpose of assimilating information.

* * *

As was the case with Sternberg's paper, it is again helpful to distinguish between two questions:

- What is the best way to teach people to read, and
- Assuming that general reading ability can be improved as

a result of improving certain skills that are believed to be critical to the reading process, how might one go about teaching these skills?

Frederiksen addresses the second question more clearly than he addresses the first.

* * *

If these or similar games really do facilitate the learning of reading significantly, they should be of very great interest indeed to teachers of reading. Note that the amount of training that Frederiksen's subjects had with each of these games was only a few hours. Moreover, in some cases subjects seem to reach asymptotic performance rather quickly, e.g., within three or four hours.

* * *

To what extent are the game aspects of Frederiksen's programs necessary? When do they become superfluous or possibly even undesirable? Might there be cases in which players, in time, become interested primarily in learning the skill that the game is designed to teach, and wish to do so in the most efficient way possible, without the trappings of the game?

* * *

Frederiksen's work prompts several thoughts and questions about componential approaches to the teaching of reading or the teaching of high-level skills more generally. E.g.,

- If one wants to teach high-level skills by having people practice components of those skills, it is probably important to identify the right component skills on which to focus. In providing practice on "unit detection" tasks in the interest of developing reading skills, for example, how important is the selection of the specific letter sequences? Would training on sequences that cross syllabic boundaries, for example, be as effective as training on sequences that represent single phonemes or syllables?

- Is it possible (easy) to provide too much training on specific component skills?

- The order in which training of different component skills occurs is probably important. This may be especially true when the skills that must be learned are hierarchically related.

- The question of how to coordinate and integrate the training of different component skills is a key one to which the answer is not clear. Should training be focused on a single component skill until performance reaches asymptote, for example, or should skills that will eventually have to be integrated be trained more of less in parallel, etc.?

- How to relate training on component skills to development of the high-order target skill also is an open question. Should performance on component skills be brought to asymptote before any effort is made to perform the higher-order composite skill? Or should practice on the higher-order skill be mixed with focused practice on component skills?

- What role should practice on component skills play in skill maintenance as opposed to skill acquisition?

* * *

A challenge to the designer of educational games of the type developed by Frederiksen et al. is to make sure that the "game" that the player is playing is the one that he is intended to play. One should bear in mind the possibility that the goal that

the player sets himself, perhaps unwittingly, is not so much to play the game as to beat it. This is illustrated in Frederiksen's results with one game (racer) in which the player's principal objective is to stay ahead of a horse on a simulated race track by pronouncing words sufficiently quickly as they appear on the computer display. Inasmuch as the horse's movement is stopped when the computer detects voicing onset, some subjects learn to precede a vocalization of the word itself with some extraneous sound such as "ah" that suffices to stop the horse's progress. Frederiksen et al. point out that this strategy will work only within limits inasmuch as any break in vocalization would result in having the computer immediately present the next item, probably causing the subject to fall behind. Subjects apparently can accommodate to this fact, however, and modify their behavior so as to use the extraneous sound production strategy to advantage in winning the race. This is not to suggest that the effectiveness of the game as a training instrument is thereby invalidated, but only to note the fact that the game the player ends up playing may be somewhat different from the one the designer had in mind.

5. CONCLUDING COMMENTS

At the outset I noted that I would tend to focus on aspects of the three papers that seem to me to be debatable, and for the most part, that is what I have done. It would have been very easy to have focused on aspects of the work on which I am in full agreement. All three papers give us considerable food for thought. Sternberg makes the case well for the importance of knowing how to use context effectively to infer the meanings of unfamiliar words and provides a systematic approach that is certainly worthy of experimental study. Schneider identifies a number of issues relating to the training of complex skills and challenges what he views as some prevailing false assumptions regarding these issues. Whether or not one agrees with his assertions, they serve as very effective stimuli to force one to clarify in one's own thinking what one really believes about these important issues. Frederiksen has the temerity to tell us that learning some of the skills that are essential to reading can be made to be fun, and he comes very close to providing compelling evidence that the claim is true. At the very least, he provides some research tools that will facilitate its testing in the future. In short, all three of the papers have had useful and provocative things to say about the trainability of information-processing and problem-solving skills and in particular the complex skill of reading. It was a pleasure to

read them and a challenge to find something contentious to say about them.

6. REFERENCES

Frederiksen, J.R., Weaver, P.A., Warren, B.M., Gillotte, H.P., Rosebery, A.S., Freeman, B., & Goodman, L. A componential approach to training reading skills. BBN Report No. 5295. Final Report submitted to Office of Naval Research and National Institute of Education, March 1983.

Schneider, W. Developing skills by training to develop new automatic components. Paper presented at AERA Annual Meeting, April 1983.

Sternberg, R.J. Teaching vocabulary-building skills: A contextual approach. Paper presented at AERA Annual Meeting, April 1983.

TABLE 1. Three Methods of Vocabulary-Building Discussed by Sternberg

Method	Description	ARMCHAIR CRITERIA: Internal Connectedness	ARMCHAIR CRITERIA: External Connectedness	ARMCHAIR CRITERIA: Ease of Use
Rote Learning	Individual is either given words and definitions or asked to look up definitions to specified words in dictionary	Short dictionary definitions easy to memorize but fail to provide inter. connected representation, elaborate defin. difficult to memorize	Poor because of poorly elaborated definitions (seems to say that poor ext. comm. follows from poor int. conn.	Variable. Use of Dictionary cumbersome
Keyword	Familiar English word that sounds like a salient part of new word is used as basis for constructing a memorable image to link new word with its meaning	Visually elaborated thru imagery, but not verbally elaborated	Greater external connectedness via interaction of image of the target word with familiar word	Variable. May be individuals not provided with keywords
Learning from Context	Word is presented in several semantic contexts from which individual is to infer its meaning	Internal connectedness can be high, because different contexts illustrate different shades of meaning. There is some risk, however, that individual will not get clear idea of word's meaning from context	Strong in this regard, because the context relates the new word to other concepts	Variable, depending on the degree to which context makes meaning of word clear.